

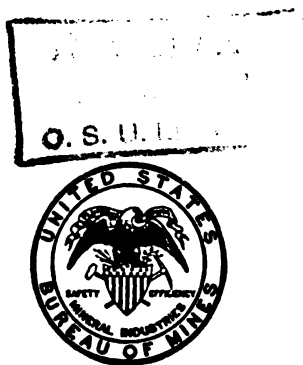
DEPARTMENT OF THE INTERIOR

UNITED STATES BUREAU OF MINES

JOHN W. FINCH, DIRECTOR

INFORMATION CIRCULAR

MINING AND REDUCTION METHODS AND COSTS AT THE
OCEANIC QUICKSILVER MINE
CAMBRIA, SAN LUIS OBISPO COUNTY, CALIF.



BY

A. W. FROLI

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OCEANIC QUICKSILVER MINE

CAMBRIA, SAN LUIS OBISPO COUNTY, CALIF.^{1/}

By A. H. Frohli^{2/}

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^{2/} One of the consulting engineers, U. S. Bureau of Mines, and Manager, Anglo American Mining Corporation, Ltd.

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INTRODUCTION

This paper, describing the mining and reduction methods and costs at the Oceanic quicksilver mine, is one of a series of similar reports being prepared by the Bureau of Mines on various mines in the United States.

The property, which is owned and operated by the Anglo American Mining Corporation, Ltd., is 5 miles east of Cambria, San Luis Obispo County, Calif. It lies in a region of steep hills and sharply incised canyons on the west slope of the Santa Lucia Range at an elevation of about 500 feet above sea level. The climate is ideal for living and operating conditions. A 40-mile paved highway connects the mine with San Luis Obispo, the nearest convenient railroad town.

ACKNOWLEDGMENTS

Acknowledgment is made to the executives of the Anglo American Mining Corporation, Ltd., for permission to present this paper for publication, and to M. J. O'Boyle, general superintendent, and other members of the company staff for their assistance in its preparation.

HISTORY

The three original claims of the Oceanic mine were located in 1865, and it is said that President Lincoln signed the patent. In 1875, the property was acquired by a corporation that began development on an ambitious scale and later erected a reduction furnace. The first recorded production was in 1876 and continued through 1879. Because of the low price of quicksilver, the mine was shut down most of the time from 1879 to 1902, when a new company obtained control and erected a 50-ton Scott furnace. Production was resumed soon after and was maintained until 1909, in spite of the depressed condition of the industry. During 1909 and 1910 the mine was operated by lessees. All the quicksilver was produced prior to 1910 from high-grade ore in coarse gray sandstone.

In 1912, the mine was acquired by Murray Innes, and soon after a large tonnage of lower-grade ore was developed in fine-grained sandstone. The furnace was rebuilt, and some quicksilver was produced. In 1916, a New York company obtained a bond on the property and built a 300-ton concentrating mill.

an aerial tramway of greater capacity than the old one, and a second 50-ton Scott furnace. It blocked out considerable ore and started mining by the sublevel caving system. Early in 1917, the bond was relinquished, and the property with all improvements reverted to Innes, who operated the mine and Scott furnaces, but not the concentrator, until 1920, when the mine was closed because of the low price of quicksilver. There was practically no output from 1910 to 1923, when a 4- by 60-foot rotary kiln and tile condenser system were erected to replace the Scott furnaces and production was resumed. In 1925, the main shaft had been deepened to the 800-foot level and some development work done.

The Consolidated Metals Corporation purchased the property on April 1, 1930, and made considerable improvements at the mine and reduction plant that resulted in lower operating costs and better quicksilver recovery. Operations were continued until July 1932, when the mine was closed again because of the low price of quicksilver. In April 1933, the assets of the Consolidated Metals Corporation were acquired by the Anglo American Mining Corporation, Ltd. Operations were resumed in June 1934, and production has been continuous since that time.

PRODUCTION

The first record of production was in 1876, when the yield was 2,358 flasks of quicksilver. From 1876 through 1879, the output was 7,391 flasks. Operations at the Oceanic mine have been interrupted by fluctuations in the price of quicksilver and numerous changes of ownership; however, it has to its credit a total production of 36,821 flasks to September 1, 1936.

For the first 8 months of 1936, an average of 75 tons of ore was treated per day and 168 flasks was produced per month. The recovery of quicksilver for this period was 5 to 6 pounds per ton, with an estimated burnt ore, stack, and mechanical loss of 5 to 10 percent.

POWER, FUEL, TIMBER, AND WATER

Electric power is purchased from the Midland Counties Public Service Corporation at a cost of 1.6 cents per kilowatt-hour; it is transmitted to the property at 11,000 volts from San Luis Obispo and is transformed to 440 volts for use at the mine and to 220 volts for use at the reduction plant.

Until April 1, 1936, a 27° plus Diesel oil was used for firing the rotary kiln and "D" retort. This oil cost \$1.67 per barrel and the furnace consumed 6.6 gallons per ton of ore treated. Since this date, an 18° plus refined crude oil has been used. The cost of this oil is \$1.24 per barrel and the furnace consumes 6.3 gallons per ton of ore treated.

Round timber for mining purposes is obtained from local pine forests. The cost of this timber delivered at the mine is as follows:

Square-set timber, peeled---3-1/2 cents per lineal foot.
Top-slice stulls, unpeeled---3-1/8 cents per lineal foot.
Round lagging, unpeeled-----1-1/2 cents per lineal foot.

Squared No. 2 common rough Oregon pine timber costs about \$25 per M board feet delivered at the mine.

Water for the mine and reduction plant is obtained from the mine and near by springs. Water for domestic use is obtained from the springs.

GEOLOGY AND ORE DEPOSITS

The geology of the Oceanic district is complicated. The rock formations belong almost entirely to the Franciscan series (generally assigned to the Jurassic), except for remnants of Miocene strata that overlies or are faulted against it. Beds of Vaqueros conglomerates and sandstones form the base of the Miocene. In the immediate vicinity of the mine, beds of basal Miocene conglomerates, sandstones, and shales have been intruded by two diabase sills. The formations are folded into a syncline and are thrust-faulted. The Franciscan formation, which is the upthrust side of the fault, makes a fault contact with the Miocene beds.

The ore mineral, principally cinnabar, is associated with pyrite and occurs in certain favorable sandstone beds. There are two distinct types of ore - (1) high-grade ore, in which the cinnabar is generally disseminated through a light-gray, coarse-grained sandstone, and (2) lower-grade ore, in which the cinnabar occurs as "nuggets", slightly tapered stems, and small particles disseminated through dark-gray fine-grained sandstones containing enough calcite to cause marked slacking on exposure. Small quantities of petroleum are associated with these sandstones. The "nuggets" are about the size and shape of an almond and are composed of variable amounts of cinnabar and pyrite. Cinnabar stems have been found varying from 1/4 to 1 inch in diameter and from a fraction of an inch to 2 feet in length. Fossil shells completely replaced by cinnabar have been found occasionally.

The outcrop of the main ore body can be traced for over 500 feet. The ore shoot, which has about the same altitude as the sandstone formations, has a N. 65° W. strike and a nearly vertical dip; it strikes to the southeast. It has a length of nearly 600 feet and a width of 15 to 40 feet. The mineralization, as a whole, is quite uniform throughout, a condition unusual for a quicksilver mine. Generally, the ore body is a disseminated deposit with no well defined walls; occasionally, local enrichment occurs along indistinct fissures.

The ore shoot has been persistent from the outcrop to the lowest level developed (700-foot level), and both high-grade and lower-grade ores have been encountered at this depth.

The thrust fault, which may be both pre-mineral and post-mineral, strikes N. 45° W. and dips 55° to 70° northeast. It cuts diagonally across the strike of the ore body and limits its extension to the southeast. Two minor cross faults displace the ore body from 10 to 20 feet horizontally. Small rhyolite

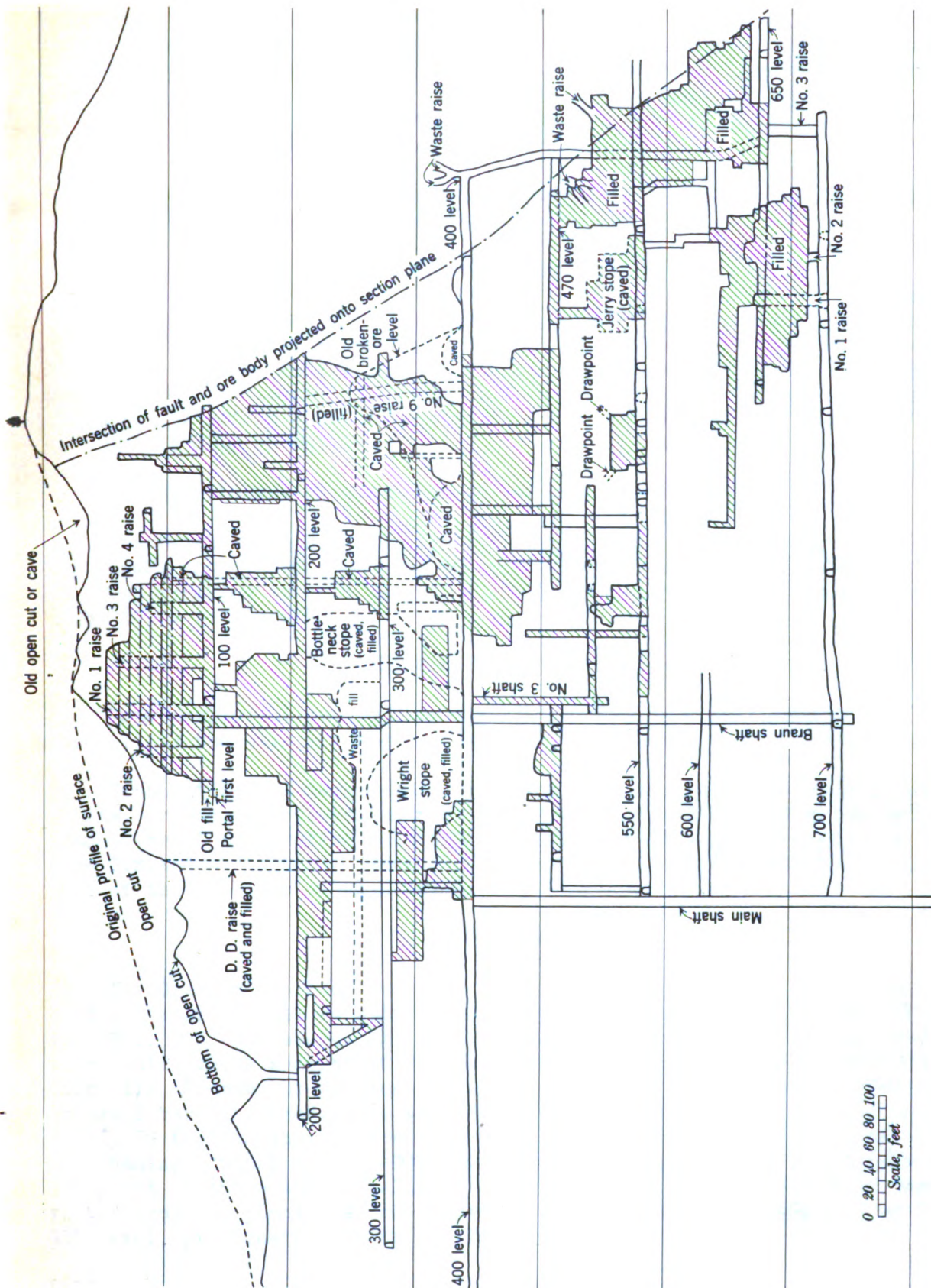


Figure 1.—Oceanic mine, Cambria, Calif. Longitudinal section N. 63° W.

intrusions along these faults have baked the country rock so that it is not favorable for the deposition of cinnabar in their immediate vicinity. In places, horizontal and vertical minor folds or flexures distort the ore-bearing sandstones a few feet. Occasionally, diabase sills are found that intrude the ore-bearing sandstones. No ore deposition occurs within a few feet of these intrusives, probably due to baking.

Some serpentine containing small amounts of cinnabar has been exposed on the northeast side of the ore body on the 700 level.

SAMPLING AND ASSAYING

Samples are taken by the mine foreman, either with a pick from the exposed development and stope faces or by grabs from the broken ore. Visual inspection of the exposed face and panning the sample after grinding are the methods used to determine the grade of the ore. These methods are sufficiently reliable and afford quick returns, which are a great help in directing development and stopping operations.

Rough estimates of ore reserves are made periodically.

For furnace control, samples are taken of the burnt ore, ground to a fine mesh, and panned. Samples are also taken of the cyclone dust and panned. At times assaying is done as a check on panning. Furnace feed samples were found to be too erratic to be of value.

PROSPECTING AND EXPLORING

Practically all prospecting has been confined to the main ore body, since it is the only important cinnabar outcrop exposed on the property.

Prospecting and development have been done by tunnels, vertical shafts, drifts, crosscuts, raises and winzes. The spotty nature of the ore makes diamond-drill exploration unsuitable. All prospecting and exploration have been limited to locating favorable sandstone strata and determining the extent of the ore body on each level.

DEVELOPMENT

The Oceanic ore body outcrops along the crest of a ridge, and the nature of the topography allows entry to the mine by several tunnels called the 100, 200, 300, and 400 levels. It is developed by 2-1/2 miles of underground workings, which reach a depth of 750 feet below the highest point of the outcrop (fig. 1). Because so many operators have worked this mine, no standard level interval has been used. The interval ranges from 50 to 140 feet; it is generally 70 feet in the upper workings and 50 feet in the lower workings. The main haulage tunnel is the 400 level, which is about 350 feet below the highest point of the outcrop. All ore mined is transported through this tunnel to the crushing plant. A two-compartment vertical shaft, beginning at the 400 level, provides access to the lower workings.

The present operations are confined principally to extracting ore from old caved stopes and abandoned blocks; the current development work consists mainly of opening old levels and preparing them for stoping.

Shafts

The Braun two-compartment vertical shaft (fig. 1) was the first main shaft sunk below the haulage level. This shaft was abandoned later because the ground caved, and the main vertical shaft was sunk in the country rock about 90 feet south of the ore body.

The main shaft has a hoisting compartment $4\frac{1}{2}$ by 5 feet and a manway compartment 4 by 5 feet in the clear. Wall, end plates, and corner posts are 10 by 10 inches; the dividers and center posts are 8 by 10 inches. All timbers are of Oregon pine.

Hoisting is done by means of a cage that will hold 1-ton cars. A single-drum, single-gear reduction hoist driven by a 75-horsepower, 900-r.p.m., 440-volt slip-ring motor is used.

Tunnels, Drifts, and Crosscuts

Tunnels, drifts, and crosscuts in country rock are 5 by 7 feet in cross section and generally do not have to be timbered. To insure a normal tonnage, it has been found practicable to develop or open old levels considerably in advance of stoping. This work includes all necessary drifts, raises, and chutes. Occasionally, crosscuts are driven to determine the width of the ore.

All drifts in the ore body are timbered with sets composed of standard caps and girts and 8-foot posts (fig. 2).

The rock is easily drilled and broken. In the development headings in ore, because of the broken or caved condition of the ground, it is necessary only to loosen the ground and square up at the face with a pick. A crew consists of a miner and mucker, who do their own mining, mucking, timbering, and track and pipe work. Sometimes this work is done by contract or under a bonus plan.

In all development work, 30 percent, 1-1/8- by 8-inch extra L.F. ammonia gelatin dynamite is used with No. 6 instantaneous and delay electric blasting caps, which are fixed with blasting machines.

Timber and supplies are kept at convenient places in the mine.

Raises and Winzes

Two-compartment square-set vertical raises are driven at convenient intervals in areas to be stoped by square-set methods.

In the top-slice section of the ore body, all raises have a chute and manway compartment. They are timbered with 4- by 8-inch cribbing 8 feet long

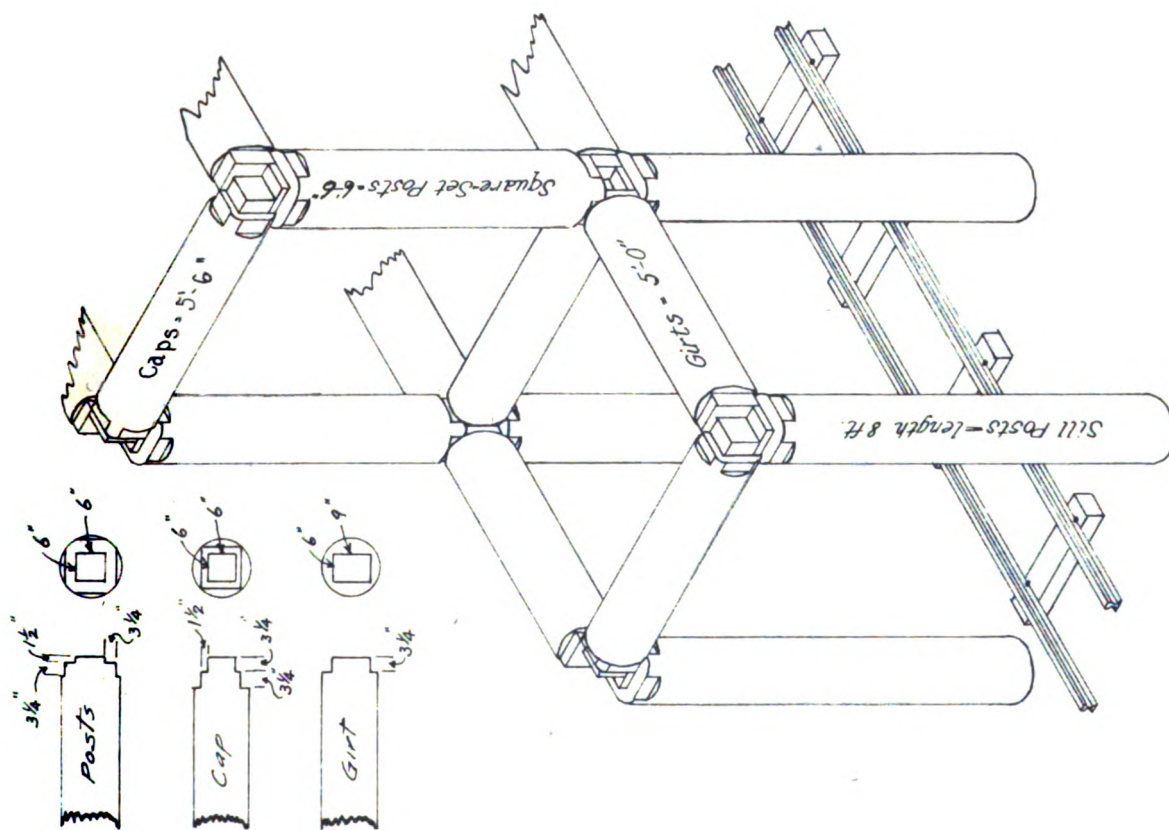


Figure 2.- Oceanic mine, standard square-sets.

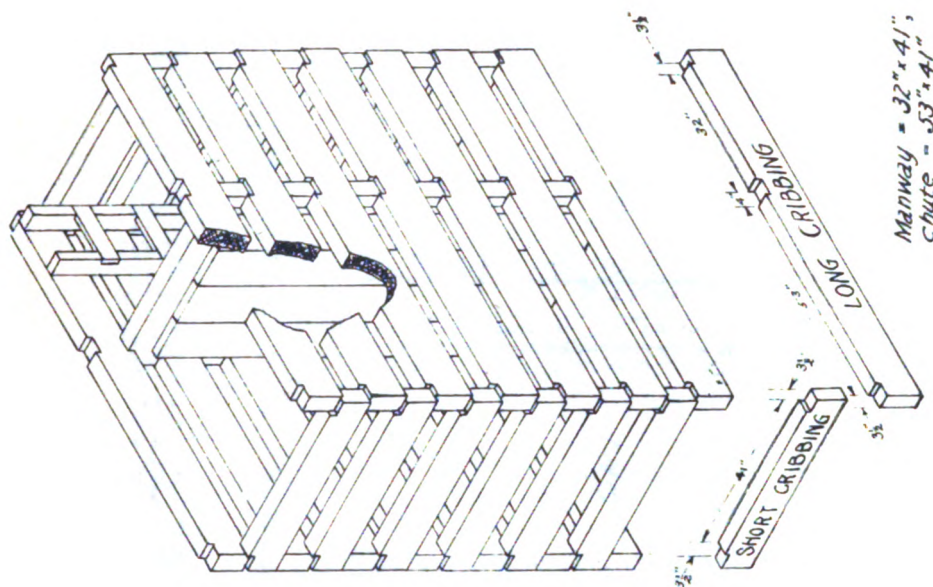
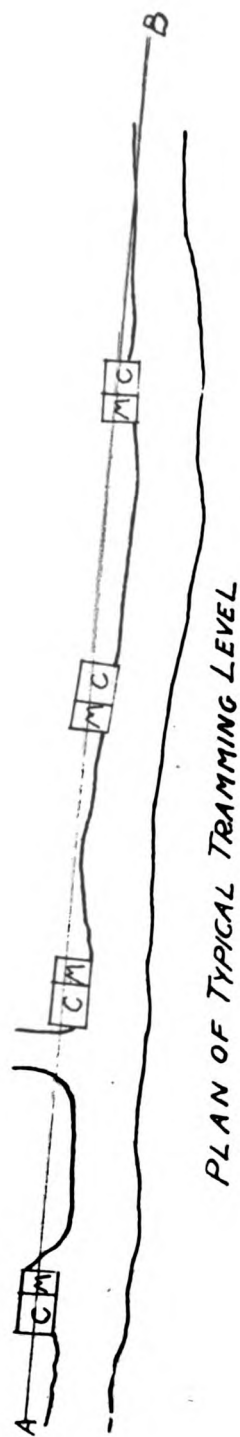


Figure 3.- Oceanic mine, cribbed chute and manway.



PLAN OF TYPICAL TRAMMING LEVEL

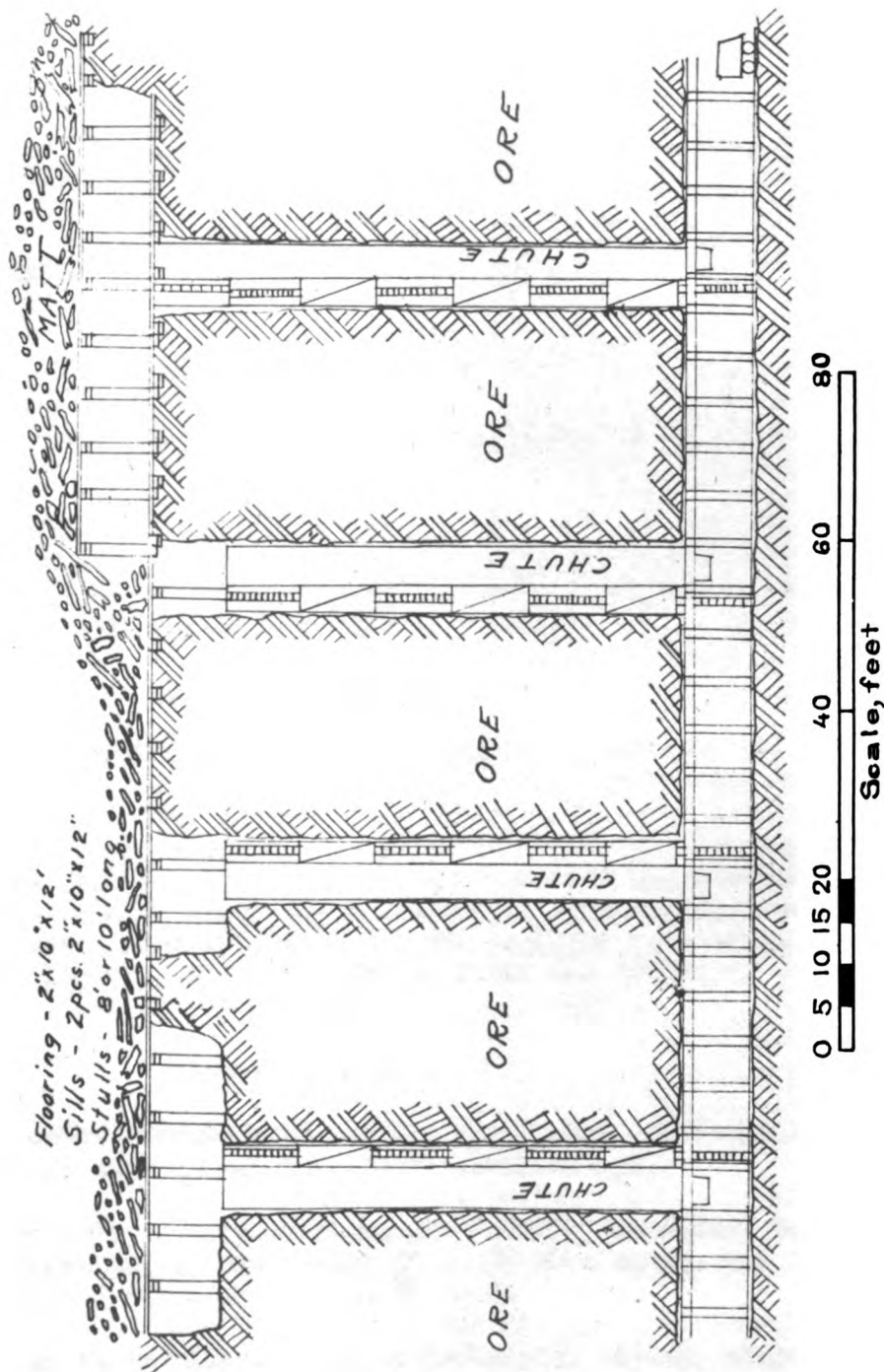


Figure 4.- Oceanic mine, typical top-slice longitudinal section through A-B.

(fig. 3). The chutes are spaced about 35 feet, center to center, except where the ground is badly broken and the cost of raising becomes so expensive that it is more economical to space them farther apart.

Vertical winzes are sunk to prospect below a level, when necessary.

MINING

In the earlier operations, surface ore was mined from an open cut about 500 feet long and 20 to 40 feet wide. Underground mining was done by the square-set method, with and without waste fill. At times, ore was drawn from the unfilled stopes until the walls caved and the ore became too diluted with waste to be of economic value. A sublevel caving method was tried later but was soon discontinued.

In the latter part of 1931, the writer introduced the top-slice caving system, which is still in use. Some square-set stoping, followed with waste fill, is also being done. During 1935, about 80 percent of the ore was mined by the top-slice method and about 20 percent by the square-set method.

Generally, drilling is done by breast-holing with a jackhammer, and since the ground is usually broken or caved, no systematic round is drilled. The same type of explosives is used in stoping as in development. No sorting is done, due to the disseminated character of the ore.

Square-set Method

Square setting is employed for mining isolated sections of the ore body and pillars that are not suited to top slicing. These stopes are usually 2 to 5 sets wide and rarely over 15 sets long. Ordinarily, one floor is mined at a time, and after two or three floors are completed, depending upon the condition of the ground, all but the upper floor and chutes and manways are filled with waste. Fill is usually obtained by driving incline raises into the waste wall for about 25 feet and chambering until the back has been weakened sufficiently to cave. Figure 2 shows the assembly and dimensions of the square-set timbers.

Top-Slice Method

The top-slice method was adopted because the broken condition of both the ore body and the walls made almost any other system unsafe.

Two-compartment cribbed raises (chute and manway) are driven between levels (fig. 4). These raises are spaced 35 to 40 feet apart, but conditions may require this spacing to be as much as 60 feet.

The general plan is to mine the ore in horizontal slices, starting at the top and working down in successive stages (fig. 4). Usually, a 10-foot slice is mined, but occasionally, due to bad ground, this is reduced to 8 feet. In starting a new floor or slice a drift, usually the height of the slice, is driven from the two-compartment raise to the end of the ore. Stoping is started

by widening out the end of this drift to the limits of the ore and retreating toward the raise. Sills consisting of two pieces of No. 2 common rough Oregon pine lumber 2 by 10 inches in cross section and 12 feet long are laid, one on top of the other, crosswise of the stope on 6-foot centers. On these sills and lengthwise of the stope single pieces of the same material are laid for flooring. Lumber of this size is used, as 12-foot material is the longest that can be handled easily through the manway of a raise or an 8-foot slice; moreover, 4 by 10-inch sills have proved to be the most satisfactory; so, by doubling the 2 by 10's, the same result is obtained and the necessity of handling different sizes of lumber is obviated. Silling and flooring follow closely the removal of the ore to prevent waste rock from running in from the walls and diluting the ore. The roof or mat is supported by native-pine stulls about 8 inches in diameter and 8 and 10 feet in length, placed about 6 feet apart and directly under the sills of the slice above. When possible, raise cribbing and stulls are salvaged and used again. When stoping has advanced about 30 feet or to a point where the timbers start taking too much weight, 1-1/4-inch holes 4 to 6 inches deep are drilled in the stulls about 4 feet from the floor. These holes are loaded with a half stick of 1-1/8-inch dynamite and blasted, both instantaneous and delay electric caps being used to better control caving.

A stope crew, usually consisting of one miner and two or three muckers, does all the drilling, mucking, timbering, and blasting in a stope. All ore is shoveled by hand directly into chutes or into wheelbarrows or cars and trammed to chutes. Tugger hoists are used to supply material and equipment to stopes as well as to lower drill steel and tools.

UNDERGROUND TRANSPORTATION

Track of 12-pound rails and 18-inch gage is laid on a 1/2-percent grade. The ore is drawn from the stope chutes into 20-cubic foot end-dump cars, trammed by hand to the main ore passes, and dropped to the main haulage level or trammed to the shaft station and hoisted to the main level. It is then hand trammed to the crusher bin near the portal of the main haulage tunnel.

COMPRESSED AIR, VENTILATION, AND LIGHTING

Compressed air is furnished by a two-stage duplex air compressor having a capacity of 677 cubic feet of free air per minute and driven by a 100-horsepower motor. The air is delivered to the mine at 100 pounds pressure.

Natural and mechanical ventilation is used. Electrically driven fans and compressed-air blowers of the injector type, connected to metal pipe or Ventube, are used to ventilate stopes, dead ends, and development headings.

Occasionally, methane gas accumulates in pockets at the roof of unventilated workings. It becomes concentrated enough in places to explode if ignited by an open flame or spark. The amount of gas released into the workings appears to be controlled by the atmospheric pressure. Sections of the mine are inspected daily by the foreman with a Wolf flame safety lamp. If methane is detected in noticeable quantities, air is blown into the working place.

The presence of methane in the mine precludes the use of open lights or blasting with ordinary fuse and caps. It is necessary, therefore, to use electric cap lamps for lighting. Smoking is not permitted underground.

The Model "H" Edison electric safety cap lamp is used everywhere underground, and two sets of batteries are required for each lamp - one in use and one being charged. A battery can be used 8 hours before being recharged and 8 hours are required for recharging. Tanager battery chargers connected to a 110-volt light socket are used to charge the batteries to about 3-1/4 volts. These lamps give good illumination and the miners find them quite satisfactory. The first cost for installing these lamps is high, but the upkeep is very low.

MINE DRAINAGE

The mine produces 9,000 to 15,000 gallons of water per day depending on the season of the year. A 3-1/4 by 4-inch triplex pump driven by a 7-1/2-horsepower motor and having a capacity of 50 gallons per minute is operated 3 to 5 hours per day. It lifts the water from the 700 to the 400 level, where it runs out of the mine through a ditch. The water is acid and corrodes pipe, rail, and pump parts to some extent.

SAFETY METHODS AND FIRST-AID ORGANIZATION

A physical examination is required of all men before they are employed. This examination is made by the local doctor at Cambria. All employees are given first-aid instruction every year by a safety engineer from the U. S. Bureau of Mines. A Mine Safety Committee, consisting of five employees holds meetings twice a month, and a periodical inspection of the mine is made also. All men in the mine are required to wear safety shoes and hats. Goggles and respirators are used when necessary.

Complete tabulated records are made of all injuries, their causes, and the cost to the insurance carrier. No fatal accidents have occurred during the last 10 years. No cases of salivation in either the mine or reduction plant have been reported during the last 5 years.

CRUSHING PLANT

Ore from the mine is hand-trammed to the crushing plant and dumped onto an inclined punched plate screen with 3-inch diameter openings. This screen extends for a distance of 24 feet along the track and has a width of 3-1/2 feet. A more suitable screening arrangement is not possible because of insufficient headroom. Two 10- by 16-inch Hercules-Blake type jaw crushers with a speed of 258 revolutions per minute break the rock to a maximum of 2 inches. Due to the sticky nature of the ore, the corrugated faces of both jaws are smoothed to allow the crushed rock to slip through more easily. Rock that does not go through the screen is shoveled into the crusher by hand. The screened and crushed product drops into a 60-ton bin. A 20-horsepower motor drives the two crushers by means of a jack shaft.

AERIAL TRAMWAY

An aerial tramway 2,600 feet long, erected in 1916, transports the ore from the crusher bin to a 760-ton bin at the reduction plant. The loaded track cable is 1-1/8 inches in diameter and has 55 inside wires 3/32 inch in diameter and 13 outside wires 5/32 inch in diameter. The unloaded cable is 7/8 inch diameter having 34 inside wires 1/16 inch diameter and 14 outside wires 1/8 inch diameter. The traction cable is 5/8 inch diameter and is of 6 by 19 Lang-lay construction. Supporting the cables are five wood towers and two terminals. The longest span is 870 feet. Sixteen buckets of 10 cubic feet capacity each, or about 900 pounds of ore, are in use and travel at a speed of 380 feet per minute. The tramway has a capacity of about 23 tons per hour, with allowance for minor delays. Very little power is required to operate the tramway.

REDUCTION PLANT

Figure 5 is a flow sheet of the crushing and reduction operations.

The equipment at the reduction plant consists of a rotary kiln 60 feet long by 4 feet in diameter, lined with 1-inch asbestos insulation next to the 1/2-inch shell and then with 4-1/4 inches of firebrick. It is belt and gear driven by a 5-horsepower motor. The kiln is set at an inclination of 3/4 inch to the foot and makes one revolution in 55 seconds. Ore from the bin chute is fed automatically into the upper end of the kiln by a reciprocating type feeder consisting of an 8-inch diameter by 12-foot long pipe operated by a cam and springs (fig. 6). To prevent the ore from back-spilling into the dust chamber a set of four helical blades is set around the inside periphery of the kiln at the feed end.

The fuel oil, which is pumped to the burner at a pressure of 90 pounds per square inch, is preheated to a temperature of about 1400° F. when it passes through pipe coils above the kiln. The oil is atomized in the burner by air under a pressure of 60 pounds per square inch. The burner is at the discharge end of the kiln and the flame is projected onto the ore at a temperature of about 1,350° F.

Careful regulation of the amount of air entering the discharge end of the furnace is necessary to obtain good results. The amount of air required depends principally upon the quantity of sulphides and petroleum in the ore. If there is insufficient air to combine with the sulphur gas liberated from the sulphides, the excess sulphur will recombine with the mercury gas and form synthetic cinnabar. A good flame or combustion produces a minimum of soot.

The size of ore treated ranges from minus 2-inch to dust, and it requires about 45 minutes for a particle of ore to pass through the kiln. Under normal conditions, the kiln has a capacity of 75 tons per 24 hours. An increase of fines or moisture in the ore decreases the capacity.

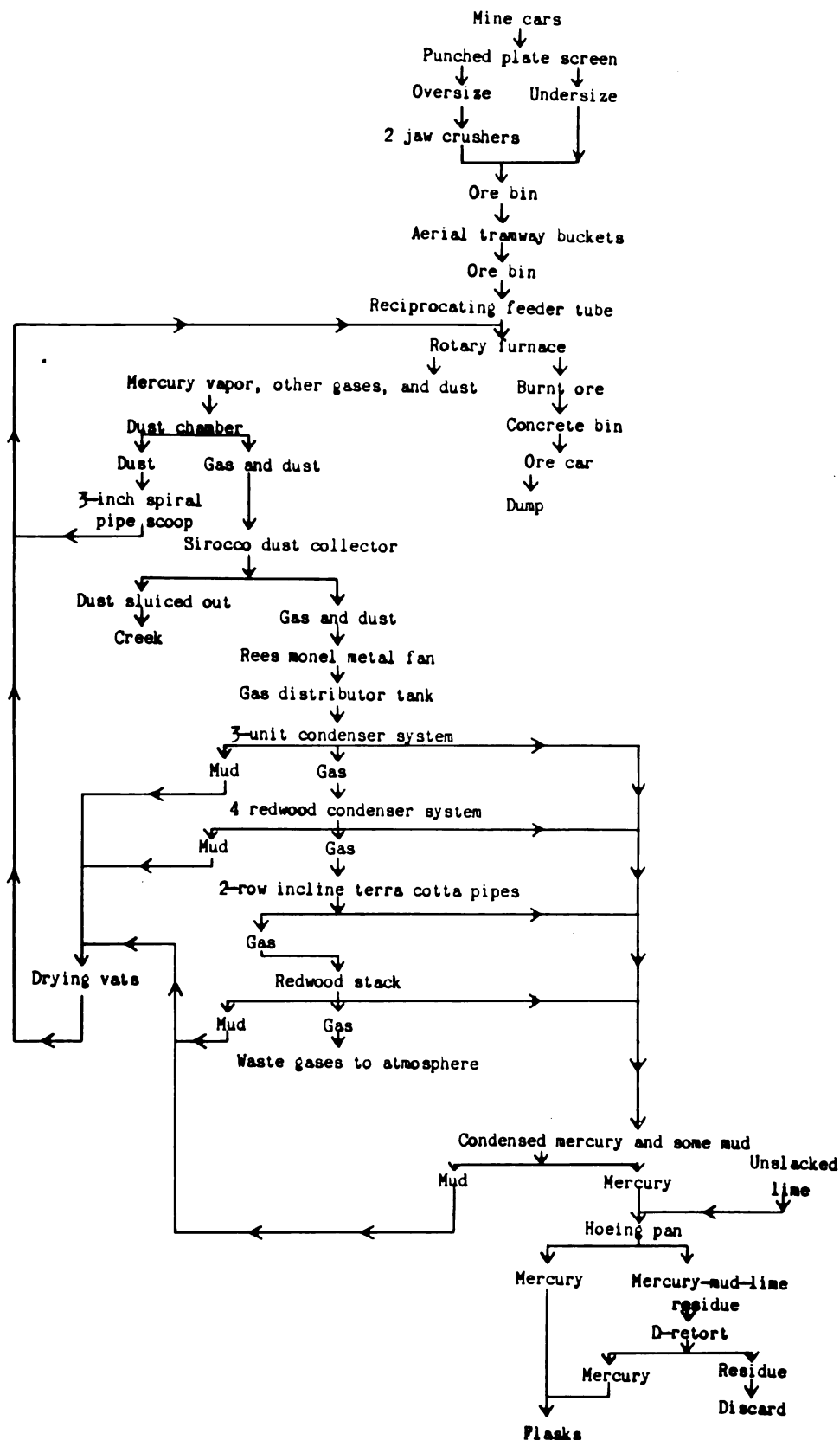


Figure 5.- Flow sheet, Oceanic reduction plant.

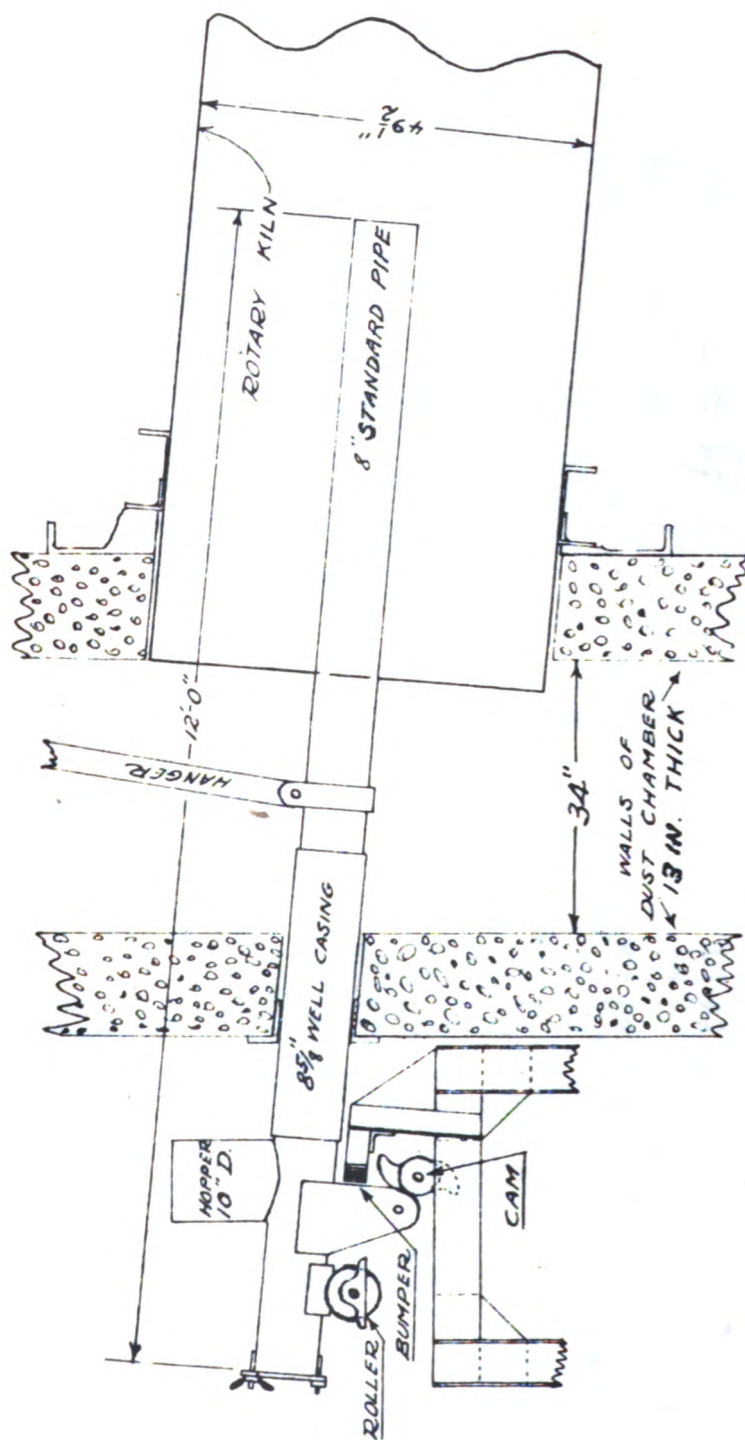


Figure 6.- Oceanic mine, 8-inch shaker feeder.

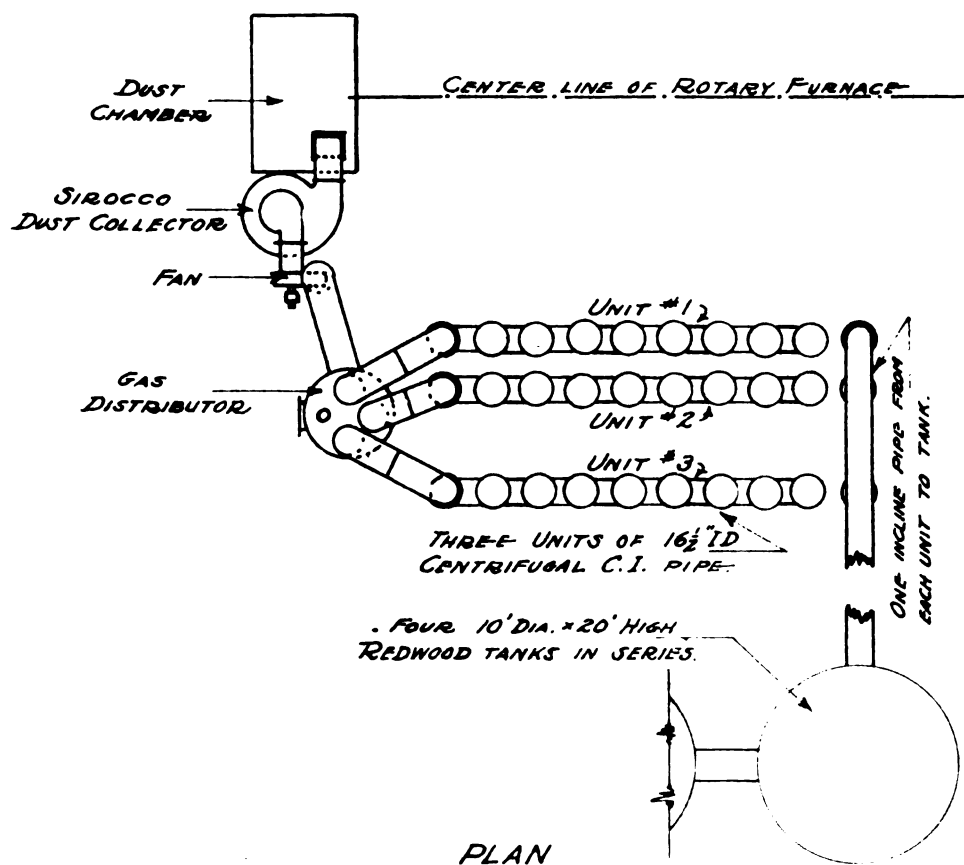
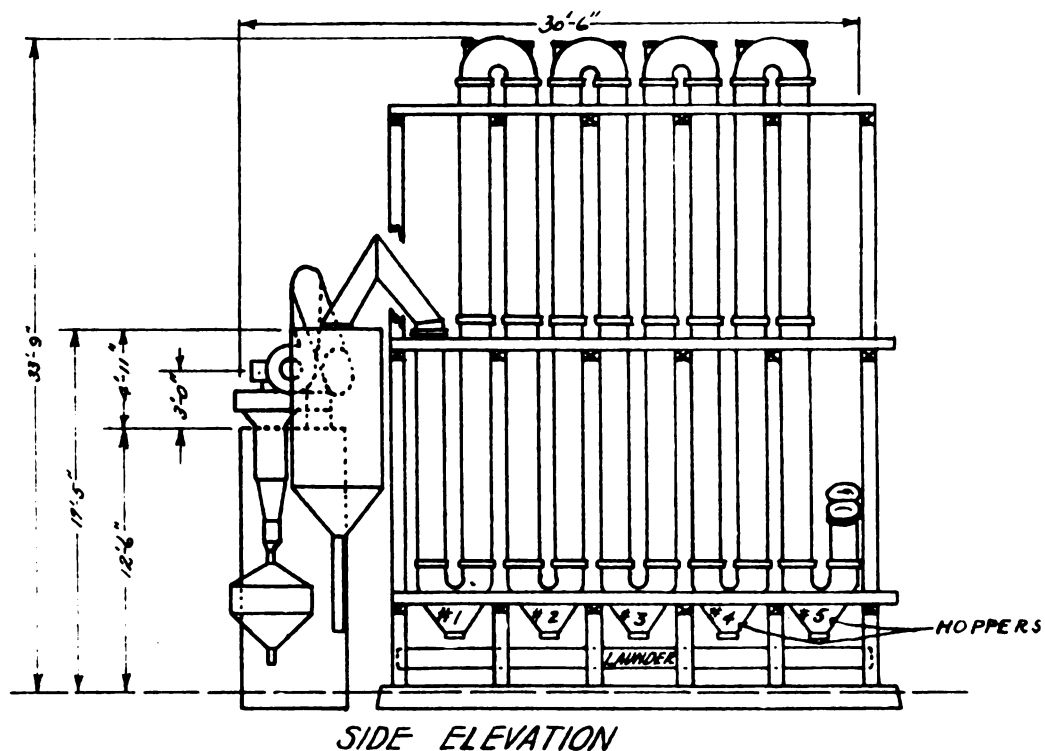


Figure 7.—Oceanic mine, condenser arrangement.

The calcined ore drops from the lower or discharge end of the kiln into a 50-ton-capacity concrete bin, from which it is drawn into 1-ton cars and hauled to the dump by a small gasoline locomotive. This burnt ore assays about 0.15 pound of mercury per ton.

Up to September 1, 1936, the kiln lining had been in use for 4 years 4-1/4 months, and 111,130 tons of ore has passed through the kiln. The lining is still in fair condition.

The upper end of the furnace is restricted to a 2-foot diameter opening, through which the mercury fumes and other gases and dust enter a concrete dust chamber. This chamber collects about 400 pounds of dust per 24 hours, which is returned to the kiln by a 3-inch spiral pipe scoop attached to the outside of the end plate of the kiln.

A 12- by 12-inch opening at the top of the dust chamber allows the gases and remaining dust to enter a No. 12, type D, Sirocco dust collector, which removes 2,000 to 2,500 pounds of dust per 24 hours. This dust, assaying about 1-3/4 pounds of mercury per ton, is discarded by sluicing it into a nearby creek. There is still a small amount of dust carried beyond here by the gases.

The gases and some dust are drawn from the dust collector into a No. 11, H. S. monel-metal, ball-bearing fan and forced through the condensing system. This fan, when driven at a speed of 2,170 r.p.m., has a capacity of 3,760 cubic feet per minute with 3-1/4 inches water vacuum at the intake.

The gases are distributed to the three condenser units by a steel tank with three discharge openings at the top. A small amount of mercury is collected from this tank during the monthly clean-up. A Bristol temperature chart records the temperature of the gases that pass through this chamber.

The three condenser units consist of three vertical rows of 16-1/2-inch inside diameter centrifugally cast iron pipe 1/2 inch thick. Figure 7 shows the layout of the condenser system. Upon entering the condenser system, the temperature of the gases has been lowered enough to cause the mercury to condense on the walls of the pipe. The globules drop into 3-gallon rubber buckets set in a launder under the spouts of the hoppers. There are five buckets to each unit. The greatest amount of mercury is recovered in the second bucket. The fourth and fifth buckets catch comparatively little mercury, and considerable dust is dropped here in the form of mud. A small amount of mercury is collected in four redwood tanks and in the inclined double terra cotta pipe line leading to the redwood stack.

Gas temperature averages for a year are as follows:

Oil flame, 1,350° F.; dust chamber discharge, 600° F.; gas distributor chamber, 380° F.; bottom of last vertical condenser pipe, 132° F.; stack, 107° F. and atmosphere, 70° F.

Since small particles of mercury adhere to the dust, it is customary to collect as much dust as possible before it gets to the stack. This is done by

installing water sprays on the inside of the last vertical condenser pipe, in the first two redwood tanks, and at the base of the stack.

Each day the mercury that has collected on the walls of the vertical condenser pipes is washed down into the buckets. A general wash-down and clean-up is made near the end of each month and requires a shut-down of the whole plant for 3-1/2 to 4 hours.

The dust collected as thin mud in the condenser system is allowed to settle in four shallow concrete vats, is dried, and then returned to the kiln.

Mercury collected in the buckets is mostly in globular form combined with some mud and a little soot. This mixture is dumped into an inclined iron pan 6-1/2 feet long by 3 feet wide and 4-1/2 inches deep and a small amount of unslaked lime added. When the lime begins to slake, the mixture is hoed back and forth and the mercury globules unite and flow as a silvery stream into a cast-iron pot set beneath the lower end of the pan. After about 50 percent of the mercury is hoed free, the residue is placed in iron pans and treated for 8 hours in a D retort 8 feet long. The condensed mercury runs into a cast-iron pot and the residue is discarded. The mercury is sold in iron flasks holding 76 pounds 1 ounce.

The retort furnace is fired with an oil burner similar to that used in the rotary kiln under the same oil and air pressure. It consumes about 50 gallons of oil per 24 hours. The life of gray-iron D retort is generally 9 to 10 months if it is used continuously. A pyrocast D retort is now being tried.

LABOR

Most of the work is done on company account although a bonus system is sometimes used.

The wage scale based on an 8-hour shift and in effect since June 1934 is as follows:

Miners -----	\$4.00
Timbermen -----	4.00
Muckers and carmen -----	3.50
Laborers -----	3.50
Blacksmith -----	5.25
Timber framer -----	4.50
Hoistmen -----	4.00
Crushermen -----	3.50
Tramway operators -----	4.00
Furnace operators -----	4.00

There is an average of 32 men employed at the mine - 1-1/2 on the tramway and 7 at the crushing and reduction plant.

COSTS

Table 1 shows the mining costs per ton of ore treated in 1935. No separate costs were kept on the square-set and top-slice stopping methods. The tons of ore mined during the year was within a few tons of the ore treated.

TABLE 1. - Mining costs, excluding development, 1935^{1/}

Mining method: Top-slice. 80 percent; square-set, 20 percent.

Tonnage treated: 26,810.

	Mining cost		Mining cost
Labor ^{2/} -----	\$1.426	Power -----	\$0.081
Explosives ----	.079	Compensation insurance-	.121
Timber -----	.141	Total -----	<u>\$1.925</u>
Other supplies -	.077		

^{1/} Includes mine surface expense but not reduction costs.

^{2/} Includes mine supervision.